



# 20<sup>th</sup> National Conference on Building Commissioning

## Wireless Pneumatic Thermostats:

*Quality Commissioning is Essential*

Peter Pollard, P.E.  
Principal  
kW Engineering



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# Course Description

The majority of existing commercial buildings still have pneumatic building controls. Operators of buildings with pneumatic thermostats must “drive blind” with no central information about, or control of, conditions in each zone. Wireless pneumatic thermostats (WPTs) can address this. A technology assessment found that WPTs themselves do not save anything until their functionality is put to use in enabling appropriate control strategies and system improvements which save energy. The key to achieving real savings is in the commissioning of the HVAC system with the new WPT capabilities, including correct integration with related control systems.



# Learning Objectives



**At the end of this session, participants will be able to:**

- 1. Describe components and functions of Wireless Pneumatic Thermostat (WPT) systems.**
- 2. Describe energy saving measures potentially enabled by WPTs.**
- 3. Describe a case study WPT installation.**
- 4. Explain why commissioning can increase energy savings from WPTs.**
- 5. Summarize lessons learned to date for WPT applications.**

# What We'll Cover

## **Wireless Pneumatic Thermostats (WPT)**

- Project Background
- WPT – What Is It?
- Energy Saving Measures
- It's What You Do With the Widgets
- Case Study: Oakland Office building
- Lessons Learned

# WPT – Project Background

## Technology Assessment for PG&E

- Utility considering offering hybrid deemed rebates
- Study 4-5 pilot sites with planned WPT installations (1 fully complete to date)
- Perform pre- and post-M&V to quantify energy savings
- Identify key factors determining the level of energy savings



# WPT – What Is It?

## Digital control of existing pneumatics

- Most existing commercial buildings still have pneumatic building controls
- Operators must “drive blind”
  - No central information about conditions in each zone
  - No central control of conditions in each zone
- WPTs are direct “plug-and-play” replacements of pneumatic thermostats



# WPT – What Is It?

- Same pneumatics controlling duct box
  - ie. damper, HW valve
- WPT's add wireless communication
  - Input/output from central hub (BMS)
- May provide added digital control
  - eg. deadband





# WPT – What Is It?

## **Digital control of existing pneumatics**

- WPTs control existing pneumatic HVAC equipment but add 2-way wireless communication with a central control hub
- Communication capability provides feedback about conditioning demand in each zone, and enables central control of setpoints in each zone
- Can enable energy-saving measures
- Lower cost and easier installation than a full DDC conversion

# WPT – What Is It?

## WPTs provide zone information

- Know temperatures at all t-stat locations
  - Web
  - BMS (through BACnet/IP)
- Know branch pressures
  - ~proxy for valve/damper positions
- T-stats know what time it is (scheduling lockouts, setbacks, or after hours overrides)



## But not as much as DDC

- No feedback from duct box (digital valve and damper positions, air flow sensors)

# WPT – What Is It?

## Manufacturers

- Cypress Envirosystems –
  - San Jose, CA
  - [www.cypressenvirosystems.com](http://www.cypressenvirosystems.com)
- Millennial Net –
  - Chelmsford, MA
  - [www.millennial.net](http://www.millennial.net)
- ecWizard – Pneumatic switching controller
  - Bay Area, CA
  - [www.energy-controls.com](http://www.energy-controls.com)



# WPT – Energy Saving Measures

## Can enable measures:

- Scheduling / Setbacks
  - Central, global, remote control
  - Especially for unoccupied spaces?
- Setpoint Enforcement
- Global Temperature Adjustment
  - including as Demand Response
- Deadband
  - May add separate cooling/heating setpoints



Cont'd...

# WPT – Energy Saving Measures

## Can enable measures:

- RCx / Troubleshooting
  - Applies to every site studied
- Supply Air Temp (SAT) resets
  - I.e. Based on zone conditions
- Duct Static Pressure (DSP) resets
  - I.e. Based on zone conditions



# WPT – Controls (not Widgets)

## **Controls Required**

- The WPTs alone do not necessarily save energy
- Must implement measures enabled by the WPTs
- Some central control system generally needed

# WPT – Case Study

## Oakland Office Bldg - Base

- 220,000 sq ft, 9 stories, 1931
- 2x rooftop built-up air handlers
- 2x 200-ton DX split systems
- VAV core plus perimeter heating fan-coils
- All pneumatics
- Single setpoint t-stats
- No BMS



# WPT – Oakland Office Bldg

## WPT / BMS Project

- ARRA funding
  - ‘Oakland Shines’ Program
- 264 WPTs installed March 2012
- Add BMS for central HVAC systems (DX chilling, boiler)
- Integrate WPTs with BMS

## Planned Measures

- Setpoint Enforcement
- SAT Reset
- DSP Reset
- Deadband (clg/htg setpoints)

## Oakland Shines is a Glowing Success

ARRA funds saving money and energy for Oakland businesses of all sizes

By Jennifer Roberts

Carly Bruch's building engineer is getting a lot less trouble than he used to.

From managing the historic Art Deco building at 221 Broadway in Oakland's Upper Ave and Entertainment District, in the past, when trouble would call Bruch to the engineer's office with a complaint that their space was too warm or too cool or drafty, he would get out on foot to investigate. Now, with new wireless heating, vent, cooling and air conditioning (HVAC) controls installed throughout the building, Bruch sits at his desk and propters random problems he's solving like stream-of-consciousness management program on his computer.

The work on HVAC controls systems "is saving Bruch out of his hair," said Peter, operations manager with Carlson & Wolford, which he also facilities management for the 200,000-square-foot building. "It's beautiful thing," he said. "It feels like we have a new team."

This advanced technology was installed with technical assistance and financial support offered through the Oakland Shines program, a partnership of the City of Oakland, PG&E and Quantum Energy Services & Technology, Inc. (QUEST), an energy efficiency services company. These technologies aren't just saving operations and maintenance time. They are also expected to save considerable energy and money. The wireless controls, as well as lighting upgrades in the building's hallways and stairwells, should slash 2011 Broadway's energy bill by as much as \$40,000 annually, said Brandon Horowitz, Douglas, program manager with QUEST.

Over the past 18 months, funded by a \$5 million federal stimulus grant administered by the California Energy Commission, Oakland Shines offered free start-to-finish technical



From left, Christopher Curtis of MetroWest, Carl Peter of Carlson & Wolford, Committee of PG&E and Brandon Horowitz, Douglas of QUEST

in 1970. An eye-catching, low-slung sculpture above the Broadway entrance depicts two children, a male and female, cupping a glowing globe.

The building's facade also gets its share of attention. On the first Friday night of every month, as part of the Oakland Art Museum Show, the plain rear facade — dubbed

estate development company that acquired the building in 2006, has good reason to be proud of the building's architectural heritage and its place in Oakland's lively arts scene. But he feels equally pleased by what's going on behind the walls of the 111-year-old building.

"It was a no-regret investment," he said. "That's fantastic." Curtis is quick to express his appreciation for all the parties that came together to make the facility improvements happen, including PG&E, QUEST and the City of Oakland. "It allowed us to become one of the greenest buildings in town," he said. "The green catch phrase isn't





# WPT – Oakland Office Bldg



The screenshot shows a web browser displaying a management interface for CYPRESS thermostats. The interface includes a navigation menu with options like 'Setup', 'User Administration', 'Alarm', 'Schedule', 'Advanced', and 'Help'. A table lists various thermostat nodes with their current status and sensor readings.

NodeID	Alarm	ACK	Node State	Setpoint (°F)	Cool Above (°F)	Heat Below (°F)	Zone Temp (°F)	Branch Pressure (PSI)	Battery Level	Occupancy State	Title
4001	✓		400-1	74			75.40	7.65	OK	Occupied	4/20/12 10:32:07 AM
4002	✓		400-2	74			73.85	5.95	OK	Occupied	4/20/12 10:32:07 AM
4003	✓		400-3	72			74.30	11.32	OK	Occupied	4/20/12 10:32:15 AM
4004	✓		400-4	74			74.75	8.95	OK	Occupied	4/20/12 10:32:07 AM
4005	✓		400-5	74			73.63	6.32	OK	Occupied	4/20/12 10:32:24 AM
4006	✓		400-6	74			75.85	7.65	OK	Occupied	4/20/12 10:32:06 AM
4007	✓		400-7	74			73.63	8.68	OK	Occupied	4/20/12 10:34:23 AM
4008	✓		400-8	72			75.63	12.57	OK	Occupied	4/20/12 10:32:25 AM
4009	✓		400-9	74			72.30	4.21	OK	Occupied	4/20/12 10:32:06 AM
4010	✓		400-10	74			71.28	2.11	OK	Occupied	4/20/12 10:32:06 AM
4011	✓		400-11	74			72.58	3.95	OK	Occupied	4/20/12 10:32:07 AM
4012	✓		400-12	74			76.85	2.11	OK	Occupied	4/20/12 10:32:06 AM
4013	✓		400-13	74			74.58	16.85	OK	Occupied	4/20/12 10:35:04 AM
4014	✓		400-14	75			72.75	10.79	OK	Occupied	4/20/12 10:35:21 AM
4015	✓		400-15	72			73.63	8.68	OK	Occupied	4/20/12 10:34:22 AM
4016	✓		400-16	75			72.85	11.34	OK	Occupied	4/20/12 10:33:07 AM



# WPT – Oakland Office Bldg

## Implementation

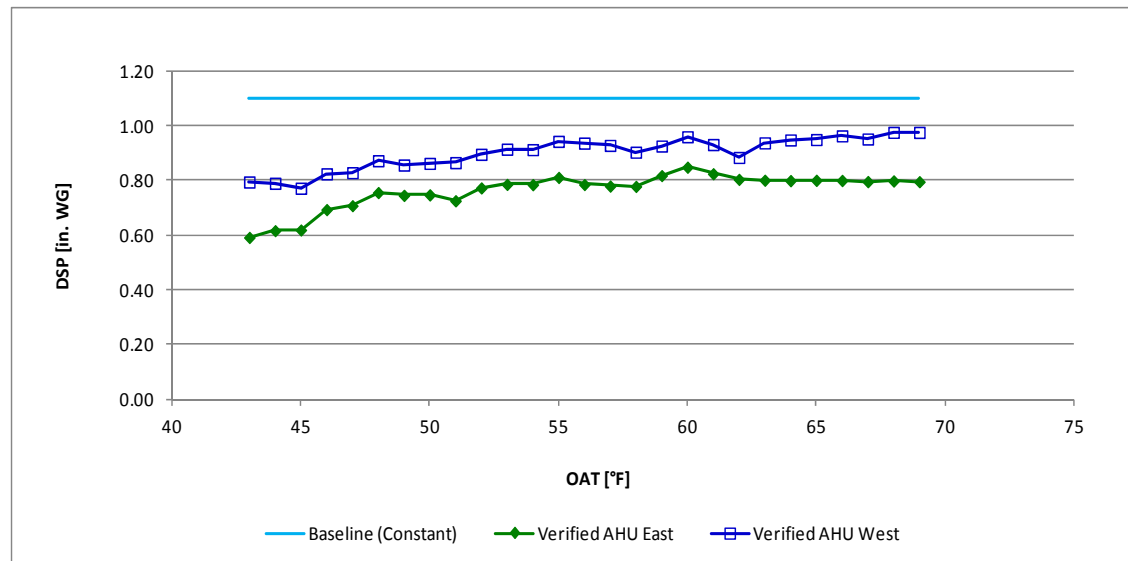
- WPT's 15 minute swap time
- 4 different t-stats found
  - Reverse/direct acting
  - Single/double pipe
- Little disruption
- 264 WPT's were installed in 5-6 weeks
- Plus controls integration time
  - ~2 more weeks
- Plus commissioning and repair time



# WPT – Oakland Office Bldg

## Achieved Measures

- Reduction of pre-heat temperature setpoint
  - From 68 to 62°F
- Identified RCx Issues for repair
- DSP Reset
  - Based on OAT (or average bldg temp)



# WPT – Oakland Office Bldg

## Energy Savings

Energy	Submitted	Verified	Realization Rate	% of Total
Peak Electric Demand [kW]	133	152	114%	
Electric Energy [kWh]	149,131	63,962	44%	<b>14%</b>
Natural Gas [therms]	2,686	5,847	218%	<b>26%</b>



# WPT – Oakland Office Bldg

## Soft Results

- Building Technician & Property Manager report:
  - Noticeably fewer hot/cold tenant calls
    - Tenants have noticed more consistent temperatures
  - Happy with having information from BMS system
    - Labor savings
  - Through the project, punch list of ~40 duct box problems was identified
    - Repairs planned over next 2 months
  - Expect marketing advantage when leasing



# WPT – Oakland Office Bldg

## Reality Check

- DSP Reset implemented, but basic
  - Does not use WPT zone information
- SAT reset based on zone information was not installed
- Pneumatics RCx issues must still be repaired
  - Disruptions needed to access duct boxes above ceiling
- Integration with BMS was poor
  - Incomplete BMS/integration scope
- Interface provided for operator is very limited
  - Certainly better than nothing (base case)
  - But much potential value not captured
  - Examples →



# WPT – Oakland Office Bldg

## Reality Check

- T-stat table lists temperatures and pressures:
  - No graphics to show room location
  - No ‘conversion’ to indicate what the pressures mean
    - 4 different t-stat types!



Stat	Temp.	Setpoint	Branch Psl.	Stat	Temp.	Setpoint	Branch Psl.
6001	74.3 °F	71 °F	14.5 psi	6023	71.4 °F	70 °F	7.9 psi
6002	75.4 °F	74 °F	10.3 psi	6024	71.8 °F	74 °F	9.8 psi
6003	73.4 °F	74 °F	9.7 psi	6025	71.6 °F	70 °F	4.5 psi
6004	73.0 °F	74 °F	9.2 psi	6026	73.4 °F	70 °F	1.6 psi
6005	76.6 °F	74 °F	4.0 psi	6027	71.8 °F	70 °F	3.4 psi
6006	75.4 °F	70 °F	1.6 psi	6028	73.1 °F	74 °F	12.1 psi
6007	74.5 °F	74 °F	7.9 psi	6029	71.6 °F	74 °F	12.3 psi
6008	74.5 °F	74 °F	8.9 psi	603A	71.2 °F	74 °F	13.2 psi
6009	74.5 °F	70 °F	3.5 psi	6031	69.8 °F	74 °F	14.2 psi
601A	75.6 °F	74 °F	6.6 psi	6032	71.4 °F	74 °F	12.6 psi
6011	73.8 °F	74 °F	9.5 psi	6033	72.5 °F	74 °F	6.4 psi
6012	72.5 °F	71 °F	6.3 psi	6034	72.9 °F	74 °F	7.6 psi
6013	72.5 °F	74 °F	13.7 psi	6035	72.7 °F	74 °F	6.7 psi
6014	73.2 °F	74 °F	7.6 psi	6036	73.8 °F	70 °F	12.6 psi
6015	73.8 °F	74 °F	8.4 psi	6037	72.1 °F	74 °F	11.8 psi
6016	72.5 °F	74 °F	11.6 psi	6038	73.2 °F	74 °F	8.8 psi
6017	72.9 °F	74 °F	12.4 psi	6039	69.8 °F	74 °F	1.6 psi
6018	72.1 °F	70 °F	4.2 psi	604A	69.2 °F	74 °F	4.2 psi
6019	72.5 °F	74 °F	10.2 psi	6041	70.7 °F	74 °F	2.4 psi
602A	72.5 °F	70 °F	4.0 psi	6042	67.5 °F	74 °F	1.1 psi
6021	71.4 °F	72 °F	7.6 psi	6043	68.2 °F	74 °F	1.5 psi

# WPT – Lessons Learned To Date

## Recommendations

- Do full retro-commissioning as part of WPT project
  - Plan on making repairs to pneumatic systems
- Don't focus only on the WPT widgets themselves
  - DO something with them!
  - Leverage their capabilities
  - Use a commissioning agent to specify controls scope
- Involve controls contractor early
  - Clearly specify integration requirements



# WPT – Conclusions

## Summary

- WPTs “can” enable many DDC-like energy savings strategies
- Gives building operators a window into what is happening in the zones
- The widgets do not save energy by themselves
- Bring controls contractor and Cx agent in at the project start
- Quality commissioning is essential



Peter Pollard, P.E.  
pollard@kw-engineering.com  
www.kw-engineering.com

